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High speed impacts on a granular material[1] YUE ZHANG, Duke University, ABRAHM CLARK, Yale University, LOU KONDIC, NJIT, BOB BEHRINGER, Duke University — When an object strikes a granular material, its momentum and energy are transferred to the grains and dissipated. When the ratio of the intruder speed, v_0, to a typical granular sound speed, c, is small, this energy transfer is intermittent along force-chain-like structures, leading to an inertial drag term proportional to the square of the intruder speed. However, many natural and industrial examples of granular impact occur much closer to $M' \equiv v_0/c \sim 1$, a regime which is difficult to reach in a lab setting using many common granular materials. To address this, we perform experiments (and matching simulations) with granular materials comprised of photoelastic disks of varying stiffness (and thus, varying c), in order to probe regimes closer to $M' \sim 1$. As M' increases, the inertial drag law fails and the material begins to behave more elastically, with a shock-like front propagating away at impact. This causes the penetration depth to be greatly reduced, and in extreme cases, the intruder can rebound temporarily. We understand this transition to damped, elastic-like behavior by comparing the grain-grain collision time to the time for the intruder to move one grain diameter.

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